

	Type	L #	Hits	Search Text	DBs	Time Stamp
1	BRS	L1	1916	((light adj emitting adj diode) laser) and gan	USPAT; US-PGP UB; EPO; JPO; DERWEN T; IBM TDB	2001/07/17 13:32
2	BRS	L2	175	1 and ni and au	USPAT; US-PGP UB; EPO; JPO; DERWEN T; IBM TDB	2001/07/17 13:30
3	BRS	L3	17	2 and ((heat adj treat) anneal)	USPAT; US-PGP UB; EPO; JPO; DERWEN T; IBM TDB	2001/07/17 13:31
4	BRS	L4	2027	((light adj emitting adj (diode diodes)) (laser lasers)) and gan	USPAT; US-PGP UB; EPO; JPO; DERWEN T; IBM TDB	2001/07/17 13:33
5	BRS	L5	179	4 and ni and au	USPAT; US-PGP UB; EPO; JPO; DERWEN T; IBM TDB	2001/07/17 13:33

	Type	L #	Hits	Search Text	DBs	Time Stamp
6	BRS	L6	115	5 and ((heat adj treat\$4) anneal\$4)	USPAT; US-PGP UB; EPO; JPO; DERWEN T; IBM TDB	2001/07/17 13:35
7	BRS	L7	48	6 and @ay<1997	USPAT; US-PGP UB; EPO; JPO; DERWEN T; IBM TDB	2001/07/17 13:36

Set Items Description  
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**Title: UV, blue and green light emitting diodes based on GaN-InGaN multiple quantum wells over sapphire and (111) spinel substrates**

Author(s): Khan MA (REPRINT) ; Chen Q; Yang J; Sun CJ; Lim B; Temkin H; Schetzina J; Shur MS

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**Abstract:** Recently Nakamura et al. have reported on high brightness visible LEDs based on **AlGaIn**-InGaIn multiple quantum wells (MQWs) using atmospheric pressure metal-organic chemical vapor deposition (MOCVD) and **AlGaIn** barrier layers around an In<sub>x</sub>Ga<sub>1-x</sub>N-In<sub>y</sub>Ga<sub>1-y</sub>N multiple quantum well region. We now report the fabrication of high brightness vertical cavity UV, blue and green light emitting diodes using low pressure MOCVD with **GaN**-In<sub>x</sub>Ga<sub>1-x</sub>N multiple quantum wells surrounded by **GaN** barrier layers. Our device structures over sapphire and cubic (111) spinel substrates consisted of a 10 period **GaN**-InGaIn MQW (25 Angstrom well-50 Angstrom barrier) surrounded by n- and p-**GaN** layers. Structures with both Mg-doped and undoped quantum wells (active regions) were deposited. Mesa type LED structures were then fabricated using Ti-Al and **Ni-Au** for the n- and p-ohmic contacts. Light emission was observed in a vertical cavity geometry from the sapphire or the spinel substrate side. For 250 mm diameter mesa devices the series resistances ranged from 10 to 25 Ohm. These are some of the lowest reported values. Spectral emission linewidths (FWHM) of 12, 25 and 40 nm were obtained respectively for the UV, blue, and green MQW LEDs. These linewidths are similar to those of Nakamura et al. We also report on optically pumped MQW InGaIn-**GaN** lasers with different quantum well thicknesses. In these devices, we observed the quantum shift related to the subband energy dependence on the well thickness and estimated the effective conduction band discontinuity at the **GaN**-InGaIn heterointerface from these data.

**Descriptors--Author Keywords:** light emitting diode ; **GaN**-InGaIn laser ; multiple quantum wells ; metal-organic chemical vapor deposition

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